

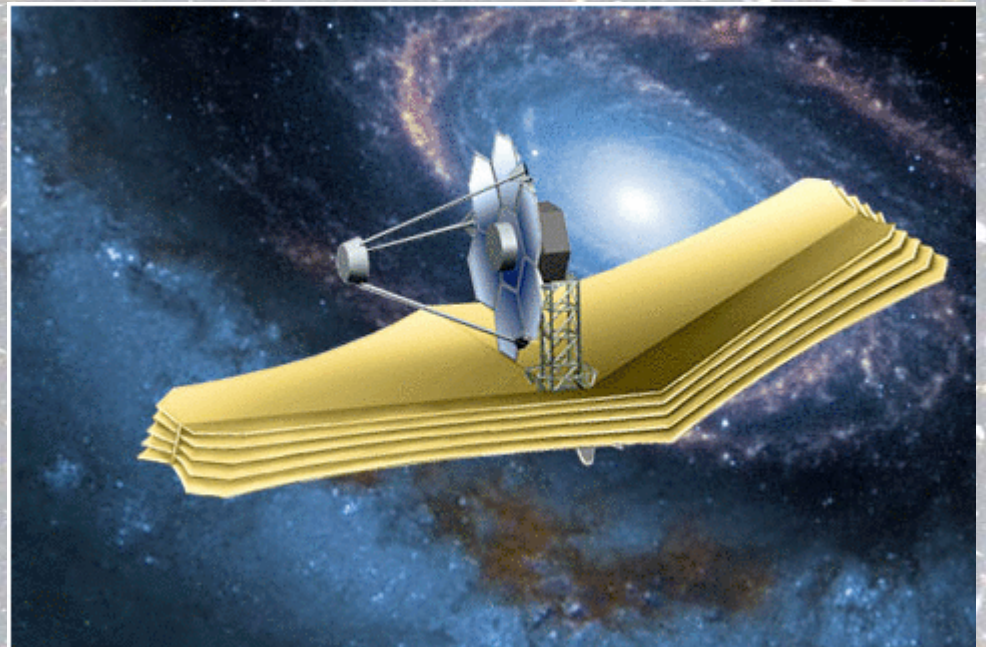
JWST and SAFIR: Near-to Far-Infrared Observatories for Origins

Marcia Rieke

NIRCam for JWST PI

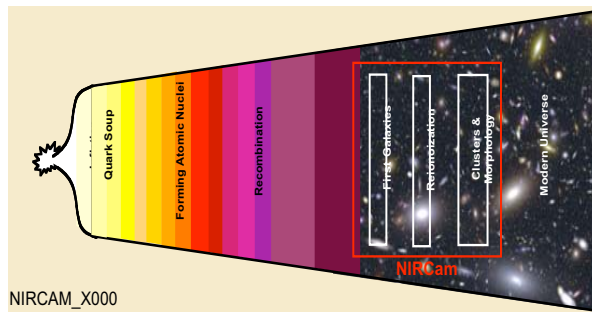


James Webb Space
Telescope



Single Aperture for Far-
Infrared

JWST's Science Themes

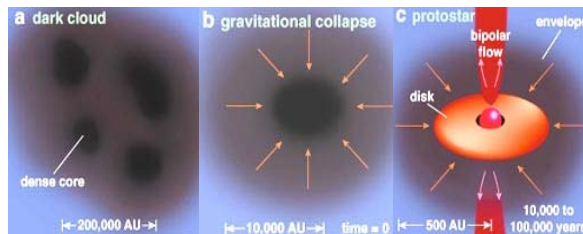


The First Light in the Universe:

Discovering the first galaxies, Reionization sources

Period of Galaxy Assembly:

Establishing the Hubble sequence, Growth of galaxy clusters



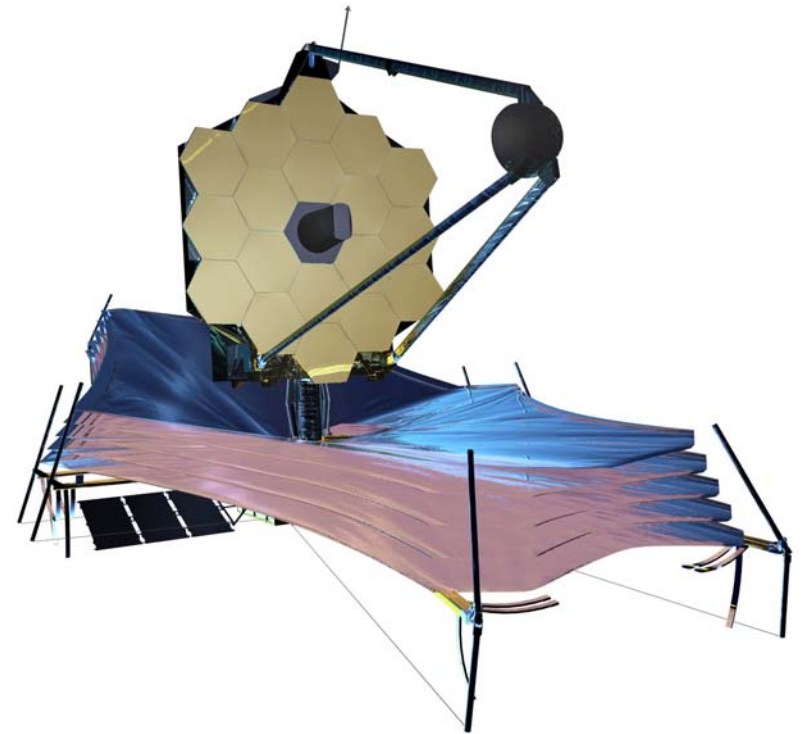
Stars and Stellar Systems: Physics of the IMF, Structure of pre-stellar cores, Emerging from the dust cocoon



Planetary Systems and the Conditions for Life: Disks from birth to maturity, Survey of KBOs, Planets around nearby stars

Summary of JWST's Capabilities

- 25 m² collecting area using a segmented primary with 6.6-m tip-to-tip diameter
- L2 orbit enables passive cooling to $\sim 45\text{K}$ for primary mirror, $\sim 35\text{K}$ for instruments
- Four instruments:
 - NIRCам, 0.6-5 μm
 - NIRSpec, 0.6-5 μm , $R \sim 100$ -3000 and multi-object
 - MIRI, 5-28 μm , camera + $R \sim 2500$ IFUs
 - FGS + TF, 1.2-4.8 μm $R \sim 100$





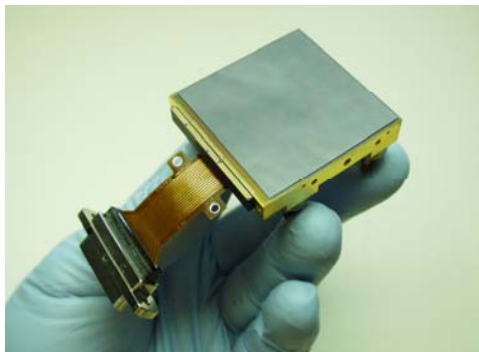
Project is moving!

- Primary mirror segments and detectors are already in production
- Instruments are prototyping optics, mounts, electronics, mechanisms

Be
mirror
blank

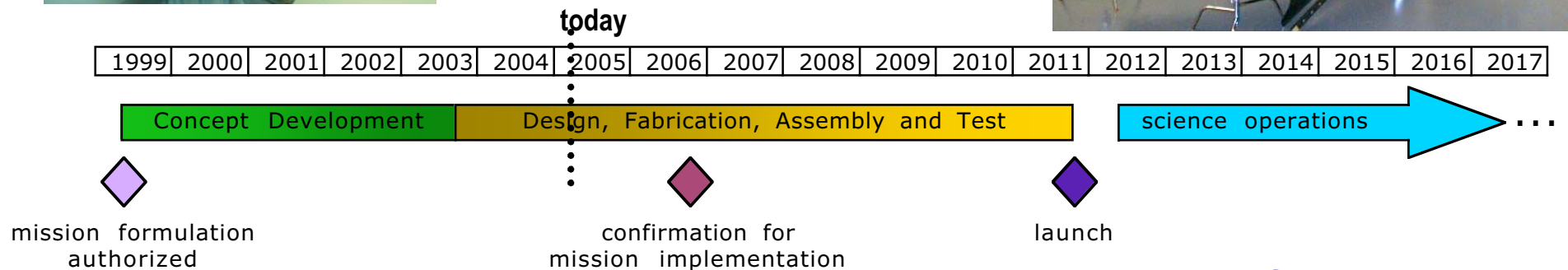


Development
mirror segment



Prototype
detector array -
7 electrons read
noise in 1000
secs!

1/3 Scale
model of
sunshade

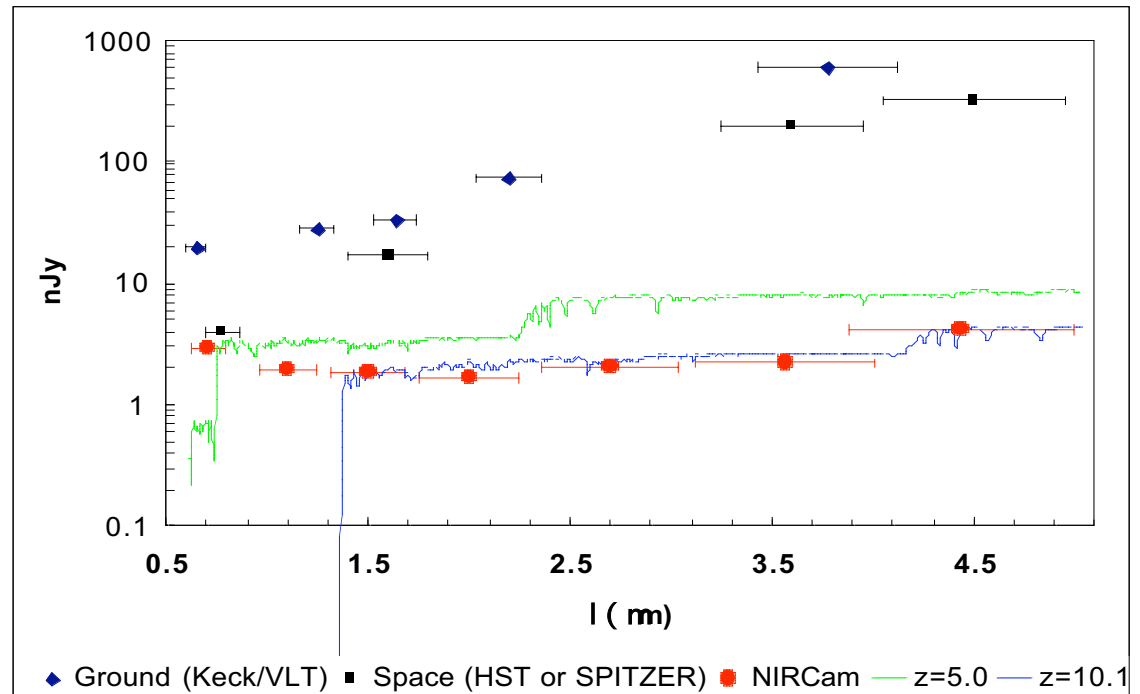


Feb 15, 2005

www.JWST.nasa.gov

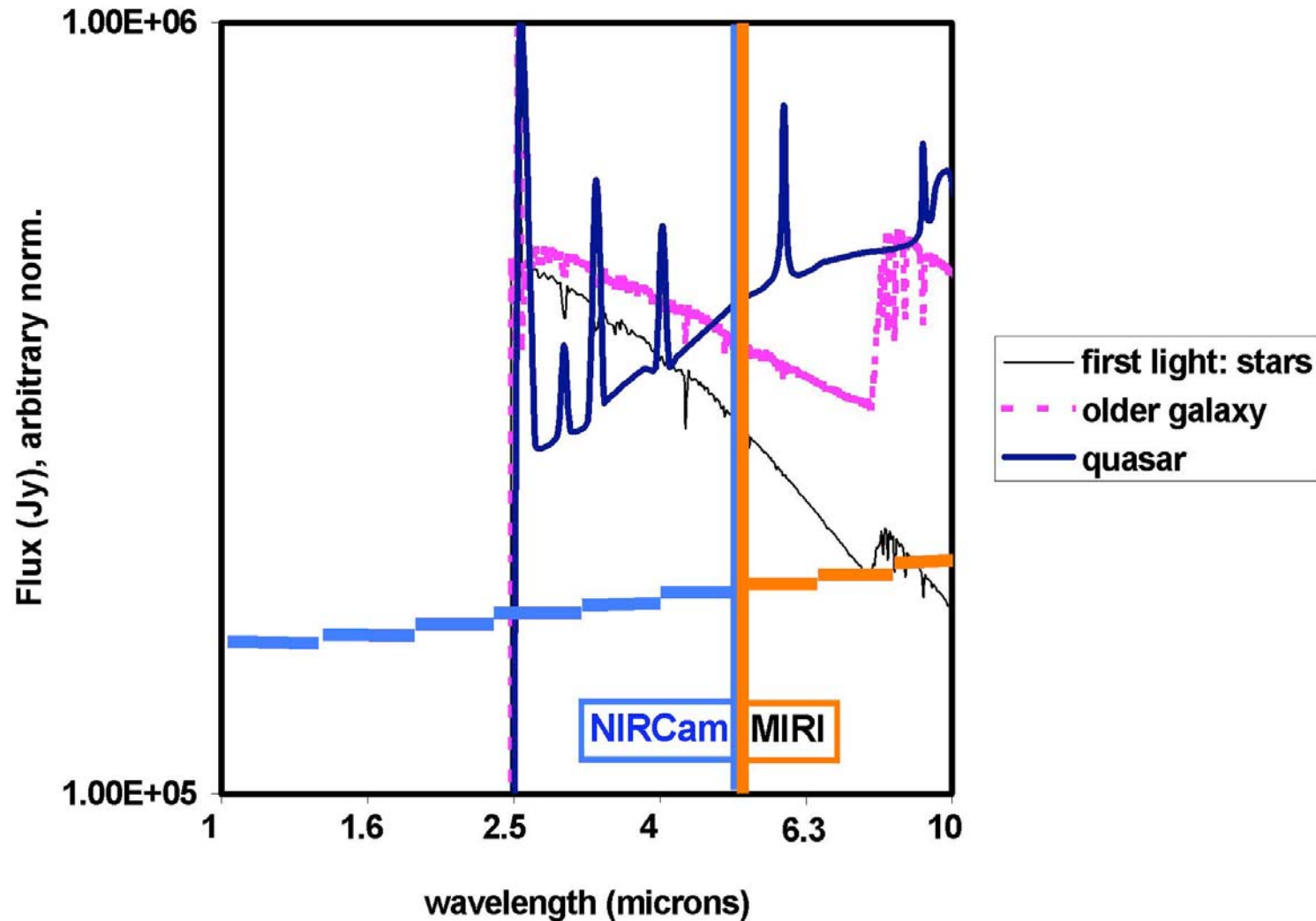
High Sensitivity is Paramount

- NIRCam sensitivity is crucial for detecting “first light” objects
- At 3-5 μ m, NIRCam can detect objects 100x fainter than Spitzer opening up new survey possibilities



The $z=10$ galaxy has a mass of $4 \times 10^8 M_{\text{Sun}}$ while the mass of the $z=5$ galaxy is $4 \times 10^9 M_{\text{Sun}}$.

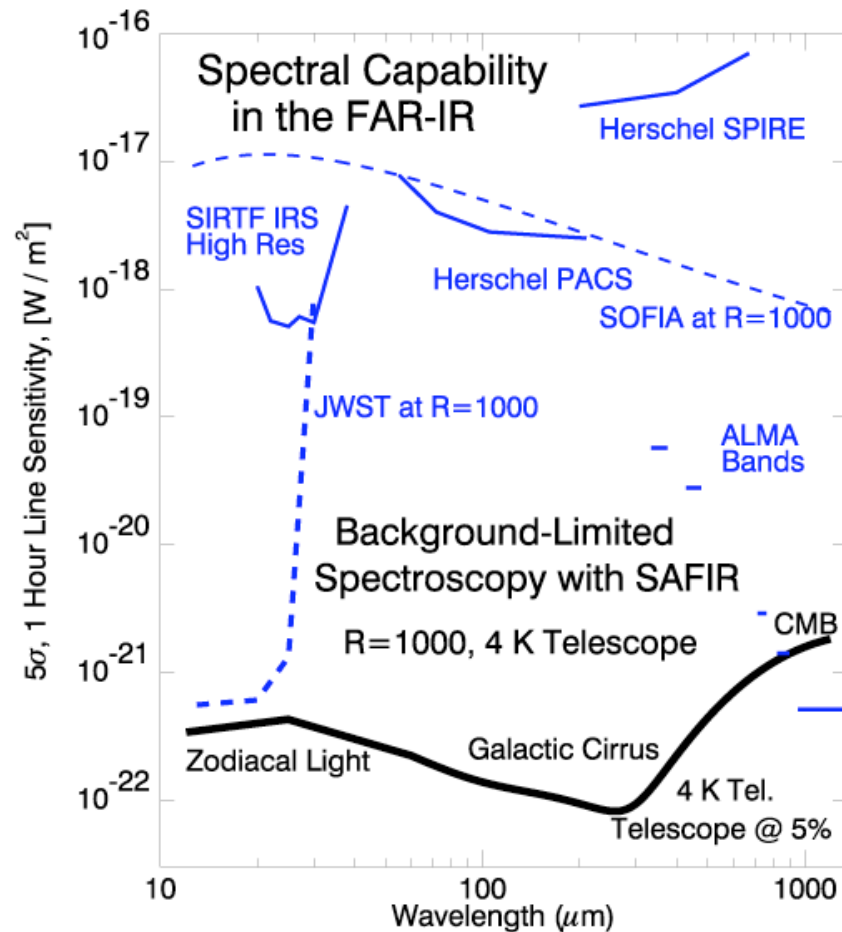
Broad Wavelength Range to be Sure



SAFIR = Single Aperture Far-Infrared Observatory

Science Goals:

- Probe the epoch of reionization due to the first stars when the universe was less than 1/20 its present age
- Trace the formation and evolution of starforming and active galaxies since their inception.
- Explore the connection between black holes and their host galaxies.
- Reveal the details of star and planet formation in nearby debris-disk systems.
- Search for and quantify prebiotic molecules in

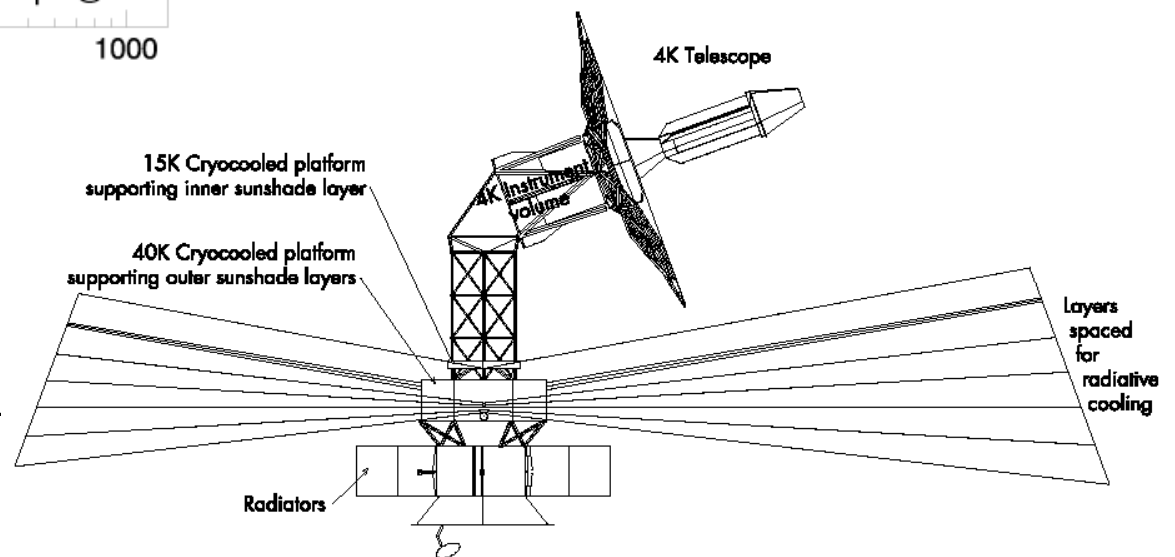


Observatory Characteristics:

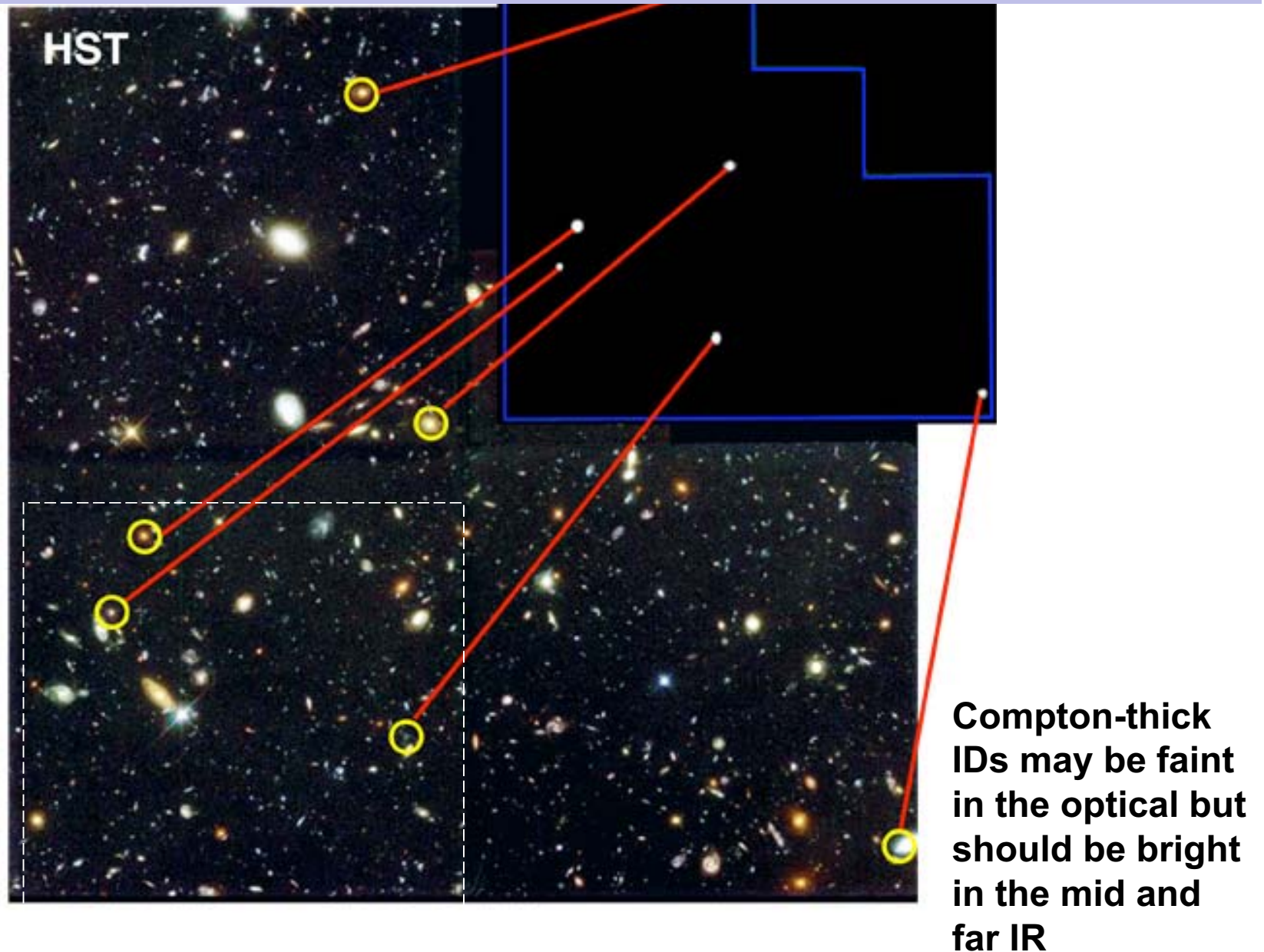
Primary Mirror Diameter: 10 m

Telescope Temperature: 5 K or lower

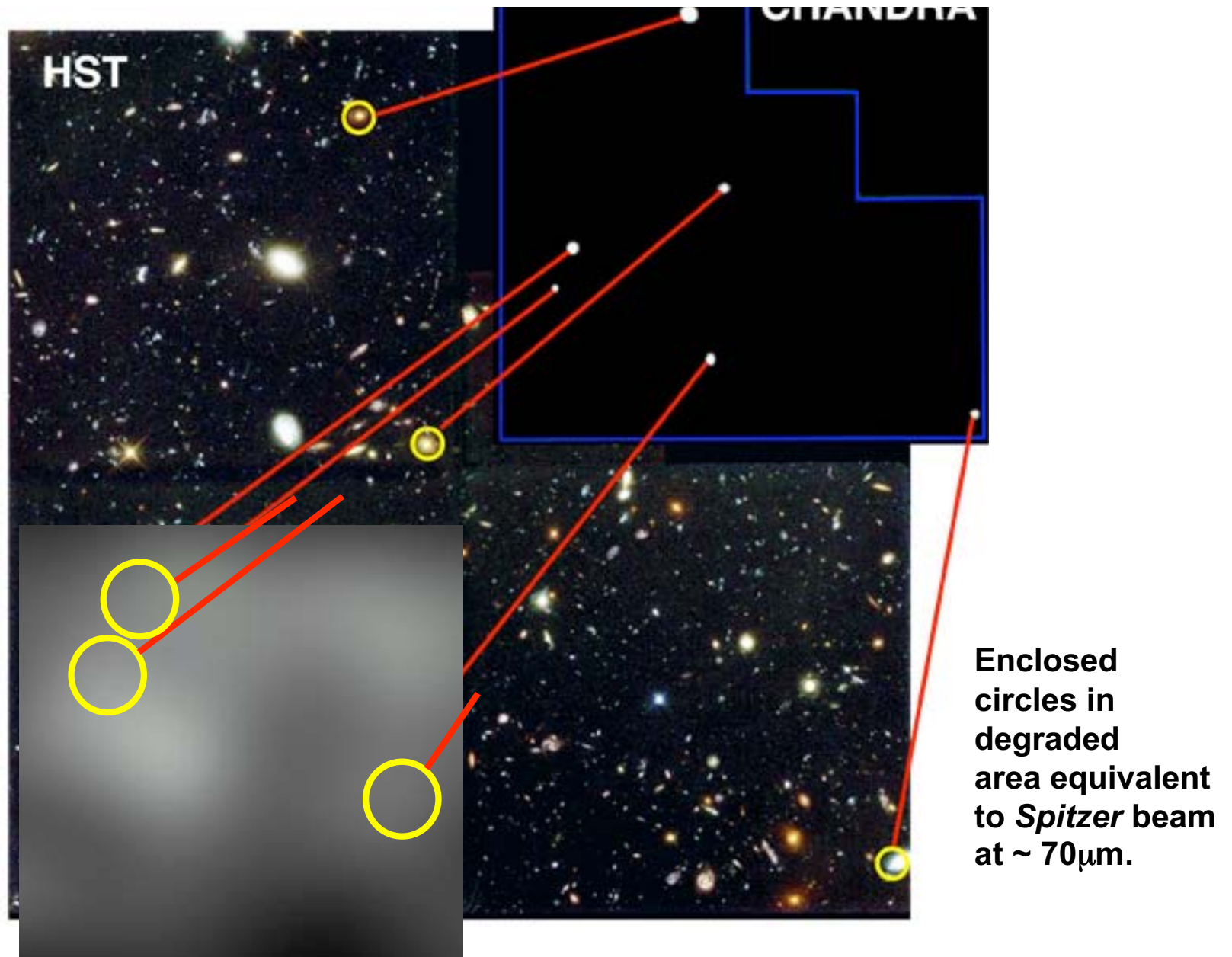
Wavelength Coverage: 20 microns to 1



The Importance of SAFIR's High Resolution:Deep Survey X-Ray Sources are Identified with Faint Galaxies

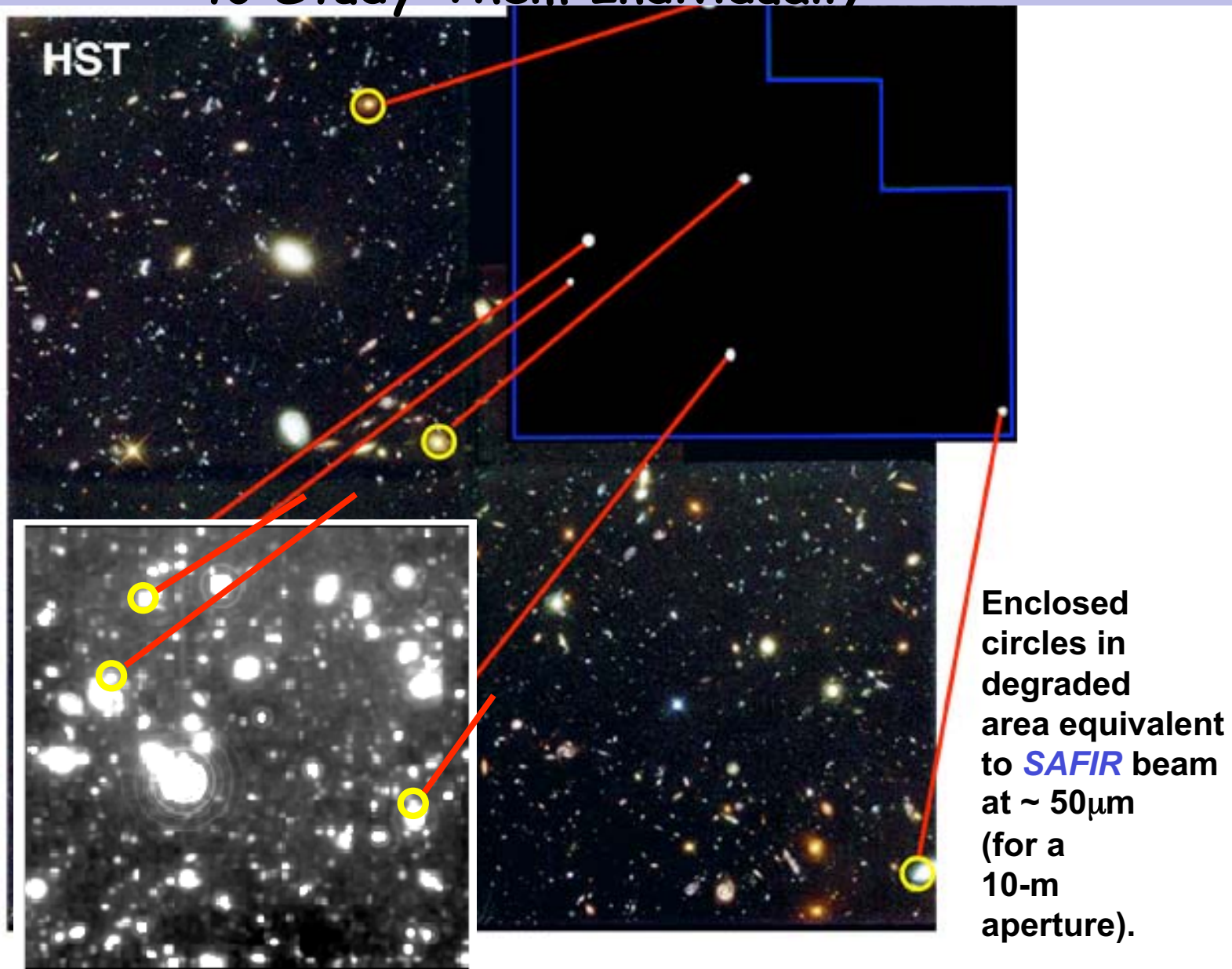


Spitzer Resolution is Inadequate to Isolate Them

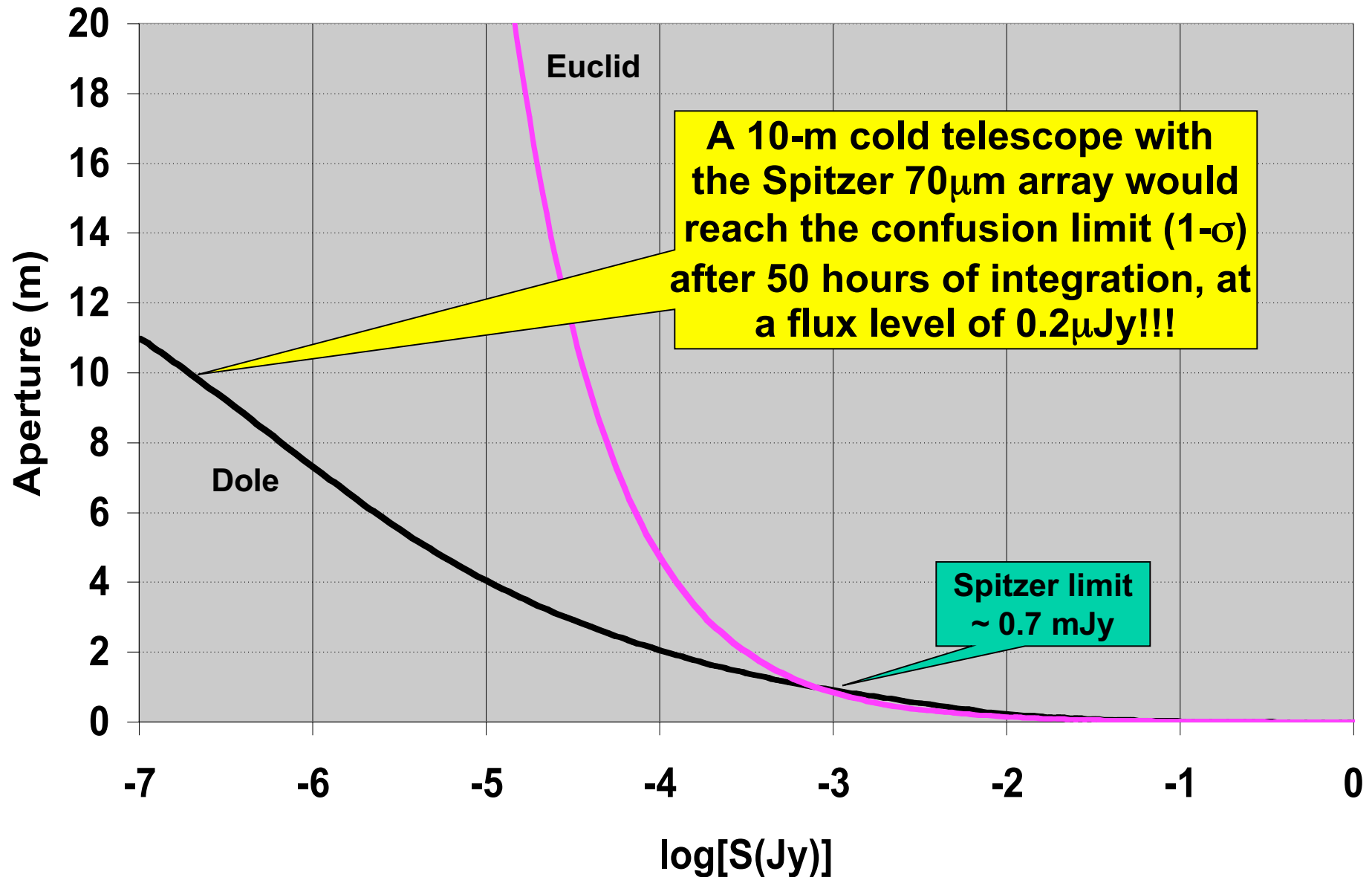


SAFIR Will Provide the Required Resolution to Study Them Individually

HST

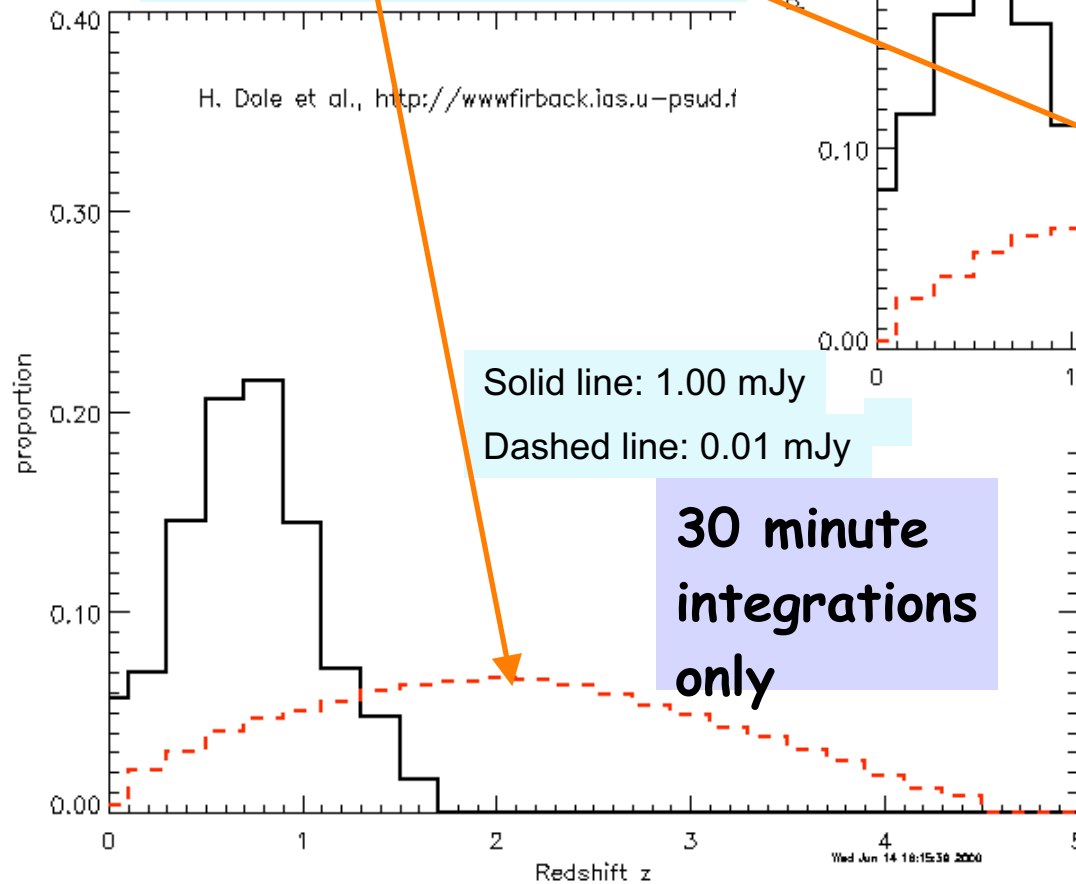


Because of the small beam, we gain rapidly on confusion as aperture grows larger than 1 meter (we resolve out the background)

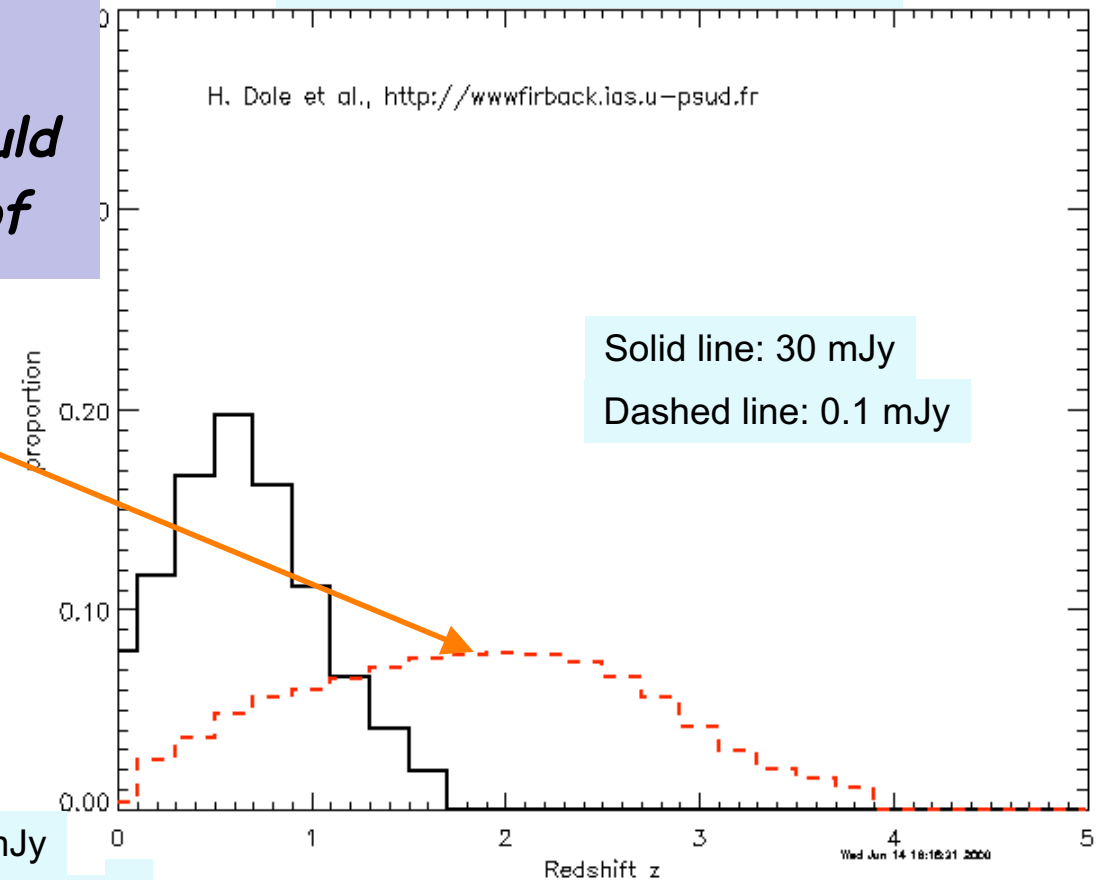


At the sensitivities of SAFIR, the detected galaxies will be distributed out to $z = 5$! *Should document the entire history of massive, dusty galaxies.*

Redshift Distribution at 70 microns

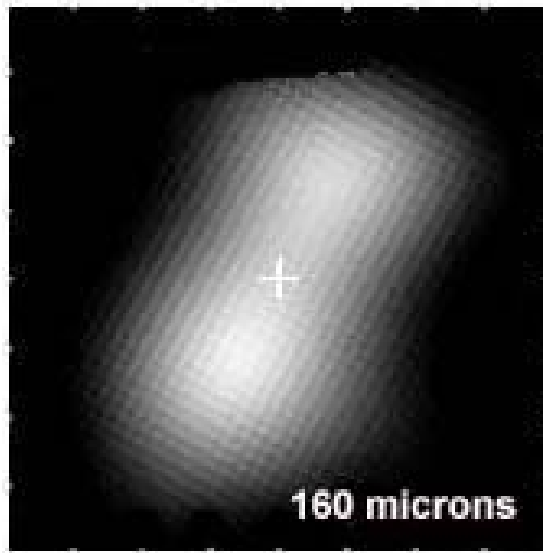


Redshift Distribution at 160 microns

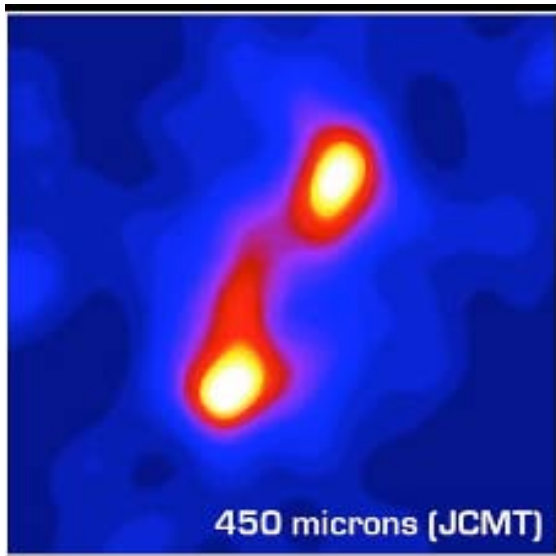
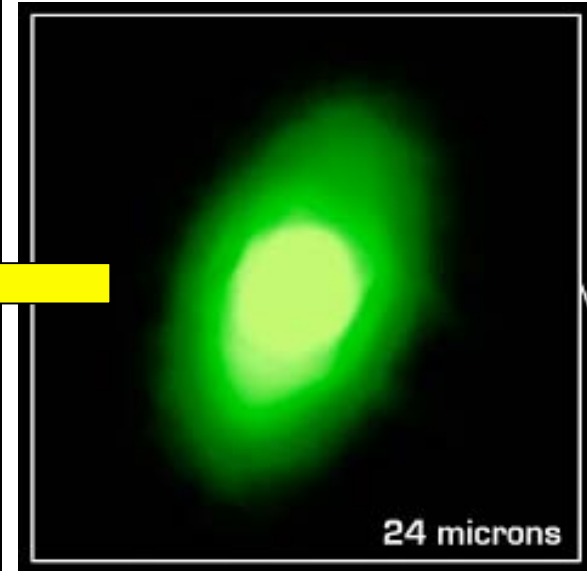
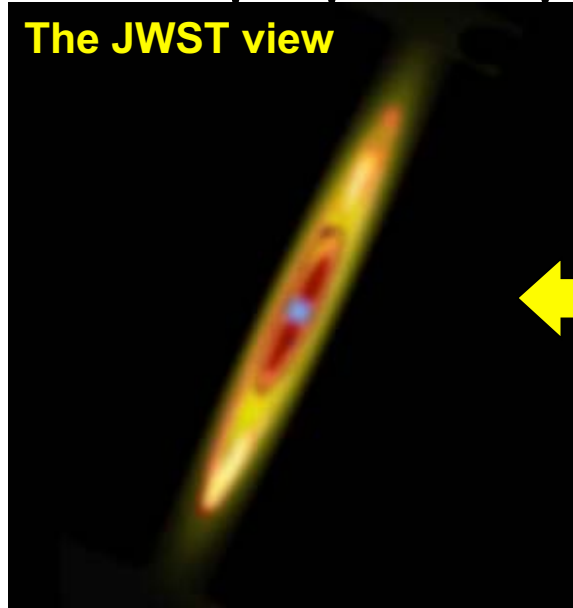


z distribution based on a model fitted to COBE background and deep ISO counts, by H. Dole.

JWST and SAFIR make major contributions to other key roadmap programs, for example planetary debris disks



The JWST view



Fomalhaut disk particles would have fallen into the star due to Poynting-Robertson drag over life of the system. They are probably the result of a collision. Disk becomes more asymmetric from submm to infrared, then fills in at $24\mu\text{m}$.

The asymmetry might be a resonance maintained by a massive planet.

Images of a Debris Disk at Different FIR Wavelengths Reveal Different Aspects of its Structure.

